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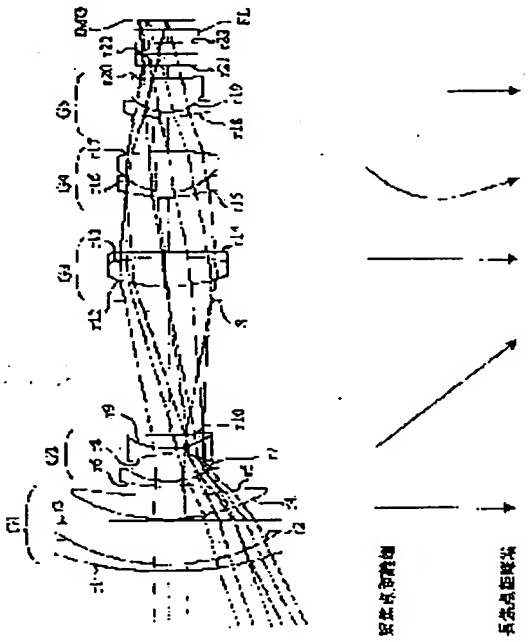
(54) ZOOM LENS AND IMAGING DEVICE USING THE SAME

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a zoom lens having superior optical performance extending over the entire object distance from an infinite-distance object to a short-distance object, while preventing an entire lens system from increasing in size.
SOLUTION: This zoom lens is equipped with a 1st group lens G1 having positive refractive power, a 2nd group lens G2 having negative refractive power, a 3rd group lens G3 having positive refractive power, a 4th group lens G4 having positive refractive power and a 5th group lens G5 having negative refractive power and consisting of at least two lenses which are a positive lens and a negative lens in this order starting from the object side. If the respective focal distances of the positive lens and the negative lens of the 5th group lens G5 are respectively defined as f51 and f52 and the refractive indexes thereof are defined as N51 and N52, the zoom lens satisfies the conditional expression: 0.002<|(1/f51)/N51+(1/f52)/N52|<0.02.



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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The 1st group lens which has forward refractive power in order [side / body], the 2nd group lens which has negative refractive power, The 3rd group lens which has forward refractive power, the 4th group lens which has forward refractive power, While it has the 5th group lens which has negative refractive power and has the positive lens and negative lens of an at least two-sheet configuration and migration of said 2nd group lens and the 4th group lens performs zooming It is the zoom lens which performs focusing by migration of said 4th group lens. When f51, f52, and each refractive index are set to N51 and N52 for each focal distance of the positive lens of said 5th group lenses, and a negative lens, The zoom lens characterized by satisfying the conditional expression which becomes $0.002<|(1/f51)(/N51+(1/f52)/N52)|<0.02$.
[Claim 2] The zoom lens according to claim 1 characterized by satisfying the conditional expression which becomes $0.95<beta5<1.09$ when photographic subject distance sets the image formation scale factor of said 5th group lens in infinite distance to beta 5.
[Claim 3] Image pick-up equipment characterized by using a zoom lens according to claim 1 or 2.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] the zooming ratio by which especially this invention is used for a home video camera etc. about the zoom lens of a rear focus type -- it is related with the zoom lens of the optimal rear focus type for the zoom lens of a high zooming ratio, and the image pick-up equipment using this by 10 times and the about 1.8-f number diameter ratio of macrostomia.
[0002]
[Description of the Prior Art] Conventionally, as a bright zoom lens of a high scale factor used for a home video camera etc. It consists of forward, negative, forward, and a 4 group lens that has each forward refractive power sequentially from a body side. It considers as as [immobilization of the 1st group lens and the 3rd group lens in zooming], the 2nd group lens is moved to an one direction, zooming is performed, by moving the 4th group lens forward and backward, image surface fluctuation accompanying zooming is amended and what performs focusing is known.
[0003] As a zoom lens of such a rear focus type, the zoom lens which has the forward 1st group lens, the negative 2nd group lens, the forward 3rd group lens, and the forward 4th group lens in order from a body side, is made to move the 2nd group lens, performs variable power, is made to move the 4th group lens, and performs focusing corresponding to the image surface fluctuation accompanying variable power is indicated by JP,63-247316,A.
[0004] Moreover, in JP,58-160913,A, it has four groups, the 1st group lens of forward refractive power, the 2nd group lens of negative refractive power, the 3rd group lens of forward refractive power, and the 4th group lens of forward refractive power, in order from a body side, and the 1st group lens and the 2nd group lens are moved, variable power is performed, and focusing of the image surface fluctuation accompanying variable power is carried out by migration of the

4th group lens. And one or two lens groups or more in these lens groups are moved, and the focus is performed.

[0005] Furthermore, in JP,58-129404,A and JP,61-258217,A, the forward 1st group lens, the negative 2nd group lens, a forward 3rd group lens, a forward 4th group lens, and a negative 5th group lens are consisted of by order, and the zoom lens which is made to move two or more lens groups containing the 5th group lens or the 5th group lens, and performs focusing is indicated.

[0006] In JP,60-6914,A, it is a zoom lens with the same refractive-power arrangement as the above-mentioned, and a zoom lens with which the location on **** of a focal lens group is not based on zooming, but becomes fixed is indicated to a certain specific finite distance.

[0007] Furthermore, in the No. 2750775 official report, the No. 2719839 official report, the No. 2832092 official report, and the No. 3109342 official report, the forward 1st group lens, the negative 2nd group lens, a forward 3rd group lens, a forward 4th group lens, and a forward or negative 5th group lens are consisted of by order, and the zoom lens which the 5th group does not move on the occasion of zooming is indicated.

[0008]

[Problem(s) to be Solved by the Invention] Generally, if a rear focus method is adopted in a zoom lens, the features whose prompt focusing the whole lens system is miniaturized and becomes possible can be acquired like the above-mentioned.

[0009] However, since the aberration fluctuation in the case of a focus becomes large too much, the trouble that it becomes very difficult to obtain high optical-character ability arises, attaining the miniaturization of the whole lens system covering the object distance at large which results in a short-distance body from an infinite distance body.

[0010] The trouble of being unable to be satisfied with the zoom lens of the high scale factor especially in the diameter ratio of macrostomia of optical-character ability high since aberration fluctuation becomes large if high optical-character ability tends to be maintained over all scale-factor range, and it is going to realize a miniaturization, and the PETTSU bar sum increases to a negative direction, and a curvature of field will become large and will cover the object distance at large further arises.

[0011] Avoiding enlargement of the further whole lens system, in case a rear focus method is mainly used for this invention and it attains formation of the diameter ratio of macrostomia, and high scale-factor-ization, it is crossed to the object distance at large [from an infinite distance body to / migrates to all the scale-factor range from a wide angle edge to a tele edge moreover, and / a short-

distance body], and aims at offer of the zoom lens which has good optical-character ability.

[0012]

[Means for Solving the Problem] This invention is accomplished in order to solve such a technical problem. Namely, the 1st group lens which has forward refractive power in order from a body side, the 2nd group lens which has negative refractive power, The 3rd group lens which has forward refractive power, the 4th group lens which has forward refractive power, While migration of the 2nd group lens and the 4th group lens performs the 5th group lens and zooming which have negative refractive power and have the positive lens and negative lens of an at least two-sheet configuration It is the zoom lens of the rear focus type which performs focusing by migration of the 4th group lens. When f51, f52, and each refractive index are set to N51 and N52 for each focal distance of the positive lens of the 5th group lenses, and a negative lens, it is the zoom lens with which are satisfied of the becoming conditional expression $0.002<|(1/f51)(/N51+(1/f52)/N52)|<0.02$. Moreover, it is also image pick-up equipment using this zoom lens.

[0013] In such a zoom lens, the PETTSU bar sum from the 1st group lens to the 4th group lens becomes large to a negative direction by advancing a miniaturization. Then, he improves the PETTSU bar sum and is trying to obtain high optical-character ability by arranging the 5th group lens in this invention. That is, in a wide angle edge, distortion aberration can be controlled to a negative direction by making it fill the above-mentioned conditional expression, making the PETTSU bar sum small.

[0014]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained based on drawing. Drawing 1 is the lens block diagram showing paraxial refractive-power arrangement of the zoom lens of the rear focus type concerning this operation gestalt. The 1st group lens of refractive power forward in G1, the 2nd group lens of refractive power negative in G2, the 3rd group lens of refractive power forward in G3, the 4th group lens of refractive power forward in G4, and G5 are the 5th group lenses of negative refractive power among drawing.

[0015] While moving the 2nd group lens G2 to an image surface side like the drawing Nakaya mark on the occasion of zooming from a wide angle edge (short focus distance edge) to a tele edge (long focal distance edge), migration of the 4th group lens G4 amended the image surface fluctuation accompanying zooming, and the rear focus type which is made to move the 4th group lens G4 on an optical axis, and performs a focus is adopted.

[0016] In addition, the 1st group lens G1, 3rd group lens G3, and the 5th group lens G5 are immobilization in the case of zooming and a focus, and when

performing a focus from an infinite distance body to a short-distance body, they are moving the 4th group lens G4 to the front.

[0017] With this operation gestalt, by arranging the above 5th group lenses G5 compared with the conventional 4 group zoom lens, the lens overall length was shortened effectively and the optical-character ability made into the purpose has been obtained. And since the zoom lens of a high scale-factor ratio with good optical-character ability is further constituted covering the object distance at large over all zooming range by specifying many optical constants of each lens group like the above-mentioned, the following conditional expression (1) and (2) are satisfied.

[0018] (1) 0.002 -- < -- |(1/f51) (/N51+ (1/f52) / N52) |<0.02(2) 0.95 -- < -- beta5<1.09 -- here, f51 and f52 express N51, and each focal distance of the positive lens of the 5th group lenses G5 and a negative lens and N52 express each refractive index. Moreover, beta 5 expresses the image formation scale factor of the 5th group lens G5.

[0019] Hereafter, the above-mentioned monograph affair type is explained. Conditional expression (1) is the conditions about the PETTSU bar sum of the 5th group lens G5, and is for maintaining good optical-character ability. In addition, if the upper limit of conditional expression (1) is exceeded, it will become difficult to make the PETTSU bar sum small, and the image surface gryposis will become large. Moreover, since the curvature of each lens side will become strong, consequently distortion aberration will increase to a negative direction in a wide angle edge if a lower limit is exceeded, it is not good.

[0020] Conditional expression (2) is for obtaining predetermined optical-character ability, shortening a lens overall length about the scale factor of the 5th group lens G5. In addition, if the scale factor of the 5th group lens G5 becomes small exceeding a lower limit, it will become difficult to attain shortening of a lens overall length. On the other hand, although it will become a configuration advantageous to shortening of a lens overall length if a scale factor becomes large exceeding a upper limit, it will become difficult to secure a predetermined back focus, or the distance of an exit pupil and the image surface will become short too much.

[0021]

[Example] Next, the numerical example of the zoom lens of this operation gestalt is explained. First, the 1st example of the numeric value of the zoom lens concerning this invention is explained, referring to drawing 2 - drawing 4 . Many aberration Figs. in a middle focal distance [in / in many aberration Figs. in a short focus distance edge / in / in drawing 2 / the 1st example / and drawing 3 / the 1st example] and drawing 4 are many aberration Figs. in the long focal distance

edge in the 1st example.

[0022] Moreover, each value of the 1st example is shown in Table 1. In addition, it is spacing of two fields where the number of a lens side adjoins each other in No of front Naka, and the radius of curvature of a field and D adjoin each other in R. The refractive index in d line and nud make Nd the Abbe number.

[0023]

[Table 1]

面番号	R	D		Nd	νd
1	34.7374	0.8000		1.84663	23.78
2	20.0880	5.2500		1.69680	55.45
3	-401.8716	0.2000		1.00000	
4	19.0186	2.7238		1.51679	64.19
5	44.4888	1.1433	可変間隔	1.00000	
6	22.3309	0.6000		1.83400	37.34
7	7.6869	3.2949		1.00000	
8	-9.6336	0.6000		1.77250	49.62
9	7.3786	1.6780		1.84666	23.78
10	64.3077	15.8311	可変間隔	1.00000	
絞り	0.0000	1.7530		1.00000	
12	* 16.63712	3.5000		1.74330	49.32
13	-29.8573	0.6000		1.69894	30.05
14	-111.7059	1.0000		1.00000	
15	0.0000	5.4824	可変間隔	1.00000	
16	16.6842	0.6000		1.82027	29.69
17	6.5679	4.8000		1.69349	53.20
18	* -30.73318	4.0344	可変間隔	1.00000	
19	18.3113	0.6000		1.80419	46.50
20	4.8565	3.9332		1.58913	61.25
21	34.7405	1.6400		1.00000	
22	0.0000	3.3500		1.51679	64.19
23	0.0000	1.9000		1.00000	

[0024] In each above-mentioned value, as for D5, D10, D15, and D18, spacing changes in connection with zooming and focusing. Therefore, each value of the 1st example when zooming is made by the tele edge from a wide angle edge is shown in Table 2. In addition, as for the focal distance of the whole system, and Fno., f of front Naka shows the f number of the whole system.

[0025]

[Table 2]

f	6.8827	32.6904	65.3778
Fno	1.8329	2.2164	3.1251
D5	1.14326	12.49431	15.97438
D10	15.83111	4.48003	1.00000
D15	5.48236	2.08164	8.54586
D18	4.03440	7.43511	0.97088

[0026] Next, R12 and R18 shall consist of the aspheric surfaces, and the aspheric surface shall be defined by the degree type.
X={C-(Y-Y)}/[1+root{1- (1+K), (C-C), and (Y-Y)}]+A4, Y4+A6, Y6+A8, Y8+A10, and Y10X: The coordinate of the direction of an optical axis of the aspheric surface is shown.
C: Curvature is shown.
Y: The distance from an optical axis X is shown.
A4, A6, A8, A10: The aspheric surface multiplier of each degree is shown.
[0027] Each aspheric surface multiplier of the 1st example is shown in Table 3.
[0028]
[Table 3]

	K	A	B	C	D
D12	-1.94404	-1.62293×10^{-4}	4.30080×10^{-7}	-2.72567×10^{-8}	4.71418×10^{-10}
D18	0.00000	5.14998×10^{-4}	-1.18484×10^{-4}	5.99461×10^{-6}	-4.97780×10^{-10}

[0029] Next, the 2nd example of the numeric value of the zoom lens concerning this invention is explained, referring to drawing 5 -7. Many aberration Figs. in a middle focal distance [in / in many aberration Figs. in a short focus distance edge / in / in drawing 5 / the 2nd example / and drawing 6 / the 2nd example] and drawing 7 are many aberration Figs. in the long focal distance edge in the 2nd example.
[0030] Moreover, each value of the 2nd example is shown in Table 4. In addition, the refractive index in d line and nud make the Abbe number spacing of two fields where the number of a lens side adjoins each other in No of front Naka, and the radius of curvature of a field and D adjoin each other in R, and Nd.
[0031]
[Table 4]

面番号	R	D		Nd	νd
1	34.20845	0.8000		1.84666	23.78
2	19.73416	5.2500		1.69680	55.45
3	-624.61425	0.2000		1.00000	
4	18.66328	2.7491		1.51680	64.19
5	43.26350	1.2416	可変間隔	1.00000	
6	19.88494	0.6000		1.83400	37.34
7	7.27496	3.4705		1.00000	
8	-9.48308	0.6000		1.77250	49.62
9	7.49004	1.7366		1.84666	23.78
10	90.62208	15.8150	可変間隔	1.00000	
絞り	0.00000	1.7530		1.00000	
12 *	18.05988	2.9076		1.74330	49.33
13 *	-90.43707	1.0000		1.00000	
14	0.00000	5.4495	可変間隔	1.00000	
15	17.13811	0.6000		1.82027	29.69
16	6.30543	4.8000		1.69350	53.20
17 *	-26.99949	5.5416	可変間隔	1.00000	
18	14.79934	0.6000		1.88300	40.81
19	4.81893	2.6000		1.58913	61.25
20	41.55954	1.6400		1.00000	
21	0.00000	3.3500		1.51680	64.20
22	0.00000	1.9100		1.00000	

[0032] In each above-mentioned value, as for D5, D10, D14, and D17, spacing changes in connection with zooming and focusing. Therefore, each value of the 2nd example when zooming is made by the tele edge from a wide angle edge is shown in Table 5. In addition, as for the focal distance of the whole system, and Fno., f of front Naka shows the f number of the whole system.

[0033]

[Table 5]

f	6.8819	32.6944	65.4018
Fno	1.8765	2.2635	3.1248
D5	1.2416	12.5375	16.0565
D10	15.8150	4.5191	1.0000
D14	5.4495	2.2066	8.9299
D17	5.5416	8.7844	2.0611

[0034] Next, R12, R13, and R17 shall consist of the aspheric surfaces, and the aspheric surface shall be defined as the 1st example by the aspheric surface type of a publication. Each aspheric surface multiplier of the 2nd example is shown in Table 6.

[0035]

[Table 6]

	K	A	B	C	D
D12	−1.94404	5.21074×10^{-4}	-1.02913×10^{-4}	2.52017×10^{-5}	-6.79267×10^{-7}
D13	0.00000	7.48355×10^{-4}	-5.54978×10^{-7}	2.26676×10^{-5}	-8.66806×10^{-7}
D17	0.00000	3.01540×10^{-4}	-2.91651×10^{-5}	7.00686×10^{-6}	-1.04557×10^{-6}

[0036] Next, the 3rd example of the numeric value of the zoom lens concerning this invention is explained, referring to drawing 8 -10. Many aberration Figs. in a middle focal distance [in / in many aberration Figs. in a short focus distance edge / in / in drawing 8 / the 3rd example / and drawing 9 / the 3rd example] and drawing 10 are many aberration Figs. in the long focal distance edge in the 3rd example.

[0037] Moreover, each value of the 3rd example is shown in Table 7. In addition, the refractive index in d line and nud make the Abbe number spacing of two fields where the number of a lens side adjoins each other in No of front Naka, and the radius of curvature of a field and D adjoin each other in R, and Nd.

[0038]

[Table 7]

面番号		R	D		Nd	νd
1		34.0992	0.8000		1.84666	23.78
2		19.6432	5.2500		1.69680	55.45
3		−672.5287	0.2000		1.00000	
4		18.6315	2.7706		1.51680	64.19
5		42.9810	1.4454	可変間隔	1.00000	
6		19.2633	0.6000		1.83400	37.34
7		7.2620	3.5217		1.00000	
8		−9.6403	0.6000		1.77250	49.62
9		7.3151	1.7696		1.84666	23.78
10		72.2371	15.6322	可変間隔	1.00000	
絞り		0.0000	1.7530		1.00000	
12	*	15.71153	3.2001		1.74330	49.33
13	*	−398.03530	1.0000		1.00000	
14		0.0000	5.6099	可変間隔	1.00000	
15		18.7323	0.6000		1.82027	29.69
16		6.3265	4.8000		1.69350	53.20
17	*	−27.80391	5.7107	可変間隔	1.00000	
18		10.5880	0.6000		1.88300	40.81
19		4.8676	2.6349		1.58913	61.25
20		19.4213	1.6400		1.00000	
21		0.0000	3.3500		1.51680	64.20
22		0.0000	1.9100		1.00000	

[0039] In each above-mentioned value, as for D5, D10, D14, and D17, spacing changes in connection with zooming and focusing. Therefore, each value of the 3rd example when zooming is made by the tele edge from a wide angle edge is shown in Table 8. In addition, as for the focal distance of the whole system, and

Fno., f of front Naka shows the f number of the whole system.

[0040]

[Table 8]

f	6.8808	32.6847	65.3995
Fno	1.851	2.2357	3.122
D5	1.4454	12.5636	16.0776
D10	15.6322	4.5140	1.0000
D14	5.6097	1.8672	10.3399
D17	5.6770	9.4195	1.0000

[0041] Next, R12, R13, and R17 shall consist of the aspheric surfaces, and the aspheric surface shall be defined as an example 1 by the aspheric surface type of a publication. Each aspheric surface multiplier of an example 3 is shown in Table 9.

[0042]

[Table 9]

	K	A	B	C	D
D12	−1.94404	1.22668×10^{-4}	-3.07265×10^{-4}	1.65844×10^{-7}	-2.72253×10^{-9}
D13	0.00000	1.48445×10^{-4}	-3.50950×10^{-4}	2.29182×10^{-7}	-4.21048×10^{-9}
D17	0.00000	6.34202×10^{-4}	-1.85814×10^{-4}	7.48192×10^{-6}	2.27273×10^{-10}

[0043] Next, the value of a monograph affair type in each example mentioned above is shown in Table 10.

[0044]

[Table 10]

条件式	数値実施例1	数値実施例2	数値実施例3
1	0.003	0.006	0.011
2	1.080	1.064	0.955

[0045] Thus, also in which example, it migrates to all zooming range and has become the zoom lens of a high scale-factor ratio with good optical-character ability covering the object distance at large further.

[0046] The zoom lens concerning this operation gestalt which gave [above-mentioned] explanation is suitable as an object for digital still cameras especially with many pixels. The important section schematic diagram of the image pick-up equipment with which drawing 11 was equipped with the zoom lens of this operation gestalt, and drawing 12 are the block diagrams explaining the internal configuration of the image pick-up equipment which used the zoom lens of this operation gestalt.

[0047] As shown in drawing 11 , this image pick-up equipment consists mainly of a digital still camera, attaches the image sensors 31, such as CCD, in the optical system 30 using the zoom lens ZL of this operation gestalt, and builds them into a case 32. Moreover, the image incorporated with the image sensor 31 can be

displayed on a liquid crystal panel 33, and it can see as a finder through an ocular 34.

[0048] As shown in drawing 12 , as an internal configuration of image pick-up equipment The image sensors 31 which change into an electrical signal the light which condensed through the optical system 30 using the zoom lens ZL of this operation gestalt, such as CCD, The image-processing section 41 which was obtained with the image sensor 31 and which incorporates and performs amendment processing, bit reduction processing, etc. to a picture signal, The image storage section 42 which stores the picture signal compressed into the predetermined format, and output I/F43 which outputs the picture signal stored in the image storage section 42 according to a predetermined protocol (interface), The lens drive control section 45 which drives the motor for performing zooming and focusing of user I/F44 for performing various setting inputs and actuation, and a zoom lens ZL, It has CPU46 which controls each part, and the liquid crystal panel 33 which displays the captured image and the memorized image.

[0049] Though it is small by applying the zoom lens ZL of this operation gestalt to such image pick-up equipment, while being able to perform zooming with little image distortion, a high definition image with little aberration can be obtained with various focal distances.

[0050] In addition, it passes over no the concrete configurations and structures of each part which were shown as said operation gestalt to what showed an example of the somatization which hits carrying out this invention, and they do not limit the technical range of this invention by these. Moreover, although the image pick-up equipment which consists of a digital still camera as an example of application of the zoom lens of this operation gestalt was explained, the video camera which can acquire an animation may be applied to other devices.

[0051]

[Effect of the Invention] As explained above, according to this invention, always by forward refractive power in order from a body side The 1st group lens of immobilization, By negative refractive power, always by the 2nd group lens mainly movable for variable power, and forward refractive power The 3rd group lens of immobilization, In the zoom lens which amendment of the focal location by zooming, the 4th group lens movable for focusing, and always consists of 5th group lenses of immobilization by forward refractive power By arranging the above 5th group lenses compared with the conventional 4 group zoom lens The formation of the diameter ratio of macrostomia and high scale-factor-ization being attained, and avoiding enlargement of the whole lens system, it migrates to all the scale-factor range from a wide angle edge to a tele edge moreover, and it becomes possible from an infinite distance body to have good optical-character

ability by the object distance at large which results in a short-distance body.

[Translation done.]